JOINT CANADA-UNITED STATES
NATIONAL STANDARD

ANSI/CAN/UL 9540:2025

STANDARD FOR SAFETY

Energy Storage Systems and Equipment

Approved American National Standard

ANSI/UL 9540-2025

SCC FOREWORD

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UL Standard for Safety for Energy Storage Systems and Equipment, ANSI/CAN/UL 9540

Third Edition, Dated June 28, 2023

Summary of Topics

This revision of ANSI/CAN/UL 9540 dated March 7, 2025 includes the addition of new Annex H to help clarify required manufacturer's installation instructions for residential ESS.

Text that has been changed in any manner or impacted by ULSE's electronic publishing system is marked with a vertical line in the margin.

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated November 1, 2024.

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ANSI/UL 9540-2025

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ANSI/CAN/UL 9540:2025

Standard for Energy Storage Systems and Equipment

First Edition – November, 2016
Second Edition – February, 2020

Third Edition

June 28, 2023

This ANSI/CAN/UL Safety Standard consists of the Third Edition including revisions through March 7, 2025.

The most recent designation of ANSI/UL 9540 as an American National Standard (ANSI) occurred on March 7, 2025. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, Preface or SCC Foreword.

This Standard has been designated as a National Standard of Canada (NSC) on March 7, 2025.

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Preface (UL)

This is the Third Edition of ANSI/CAN/UL 9540 Standard for Safety for Energy Storage Systems and Equipment.

ULSE is accredited by the American National Standards Institute (ANSI) and the Standards Council of Canada (SCC) as a Standards Development Organization (SDO).

This Standard has been developed in compliance with the requirements of ANSI and SCC for accreditation of a Standards Development Organization.

This ANSI/CAN/UL 9540 Standard is under continuous maintenance, whereby each revision is approved in compliance with the requirements of ANSI and SCC for accreditation of a Standards Development Organization. In the event that no revisions are issued for a period of four years from the date of publication, action to revise, reaffirm, or withdraw the standard shall be initiated.

In Canada, there are two official languages, English and French. All safety warnings must be in French and English. Attention is drawn to the possibility that some Canadian authorities may require additional markings and/or installation instructions to be in both official languages.

Comments or proposals for revisions on any part of the Standard may be submitted at any time. Proposals should be submitted via a Proposal Request in the Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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This Edition of the Standard has been formally approved by the Technical Committee (TC) on Energy Storage Systems and Equipment, TC 9540.

This list represents the TC 9540 membership when the final text in this Standard was balloted. Since that time, changes in the membership may have occurred.

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International Classification for Standards (ICS): 27.100; 29.220

This Standard is intended to be used for conformity assessment.

The intended primary application of this standard is stated in its scope. It is important to note that it remains the responsibility of the user of the standard to judge its suitability for this particular application.

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INTRODUCTION

1 Scope

1.1 These requirements cover an energy storage system (ESS) that is intended to receive and store energy in some form so that the ESS can provide electrical energy to loads or to the local/area electric power system (EPS) when needed. Electrochemical, chemical, mechanical, and thermal ESS are covered by this Standard. The ESS shall be constructed either as one unitary complete piece of equipment or as matched assemblies, that when connected, in accordance with the manufacturer's installation instructions, form the ESS. An ESS consists of at least an energy storage function and energy storage protective function. If the ESS includes multiple parts that are housed in separate enclosures, it shall be considered as a multi-part ESS covered by this Standard. Individual parts (e.g. power conversion equipment, a battery, etc.) of an ESS are not considered an ESS on their own. This Standard evaluates the compatibility and safety of these various components and parts integrated into an ESS. The ESS can be an AC ESS or a DC ESS as defined in this Standard.

1.2 The systems covered by this Standard include those intended to be used in a standalone mode (e.g. islanded) including "self-supply" systems to provide electrical energy and those used in parallel with an electric power system or electric utility grid such as "grid-supply" systems, or applications that perform ancillary operational modes associated with power generation such as voltage support and regulation, frequency support and regulation, volt-var, capacity reserve, energy shifting or other utility grid support services.

1.3 Energy storage systems are intended for installation and use in accordance with the National Electrical Code, NFPA 70, the Canadian Electrical Code, Part I Safety Standard for Electrical Installations, CSA C22.1, the National Electrical Safety Code, IEEE C2, the International Fire Code, ICC IFC, the International Residential Code, ICC IRC, the National Fire Code of Canada, NRC NFC, the Fire Code, NFPA 1, and the Standard for the Installation of Stationary Energy Storage Systems, NFPA 855. Requirements for installation, with the exception of installation manuals and documents for installation provided with the system are outside the scope of this Standard.

1.4 This Standard covers energy storage systems for stationary indoor and outdoor installations. This Standard also covers mobile energy storage systems as defined by this Standard. This Standard includes requirements for energy storage systems used in residential and non-residential installations.

1.5 Systems using lead acid or Ni-cad batteries that fall within the scope of UL 1778/CSA C22.2 No. 107.3 and only serve an uninterruptible power system (UPS) application are outside the scope of this Standard.

NOTE: UL 1778/CSA C22.2 No. 107.3 is applicable to UPS that employ chemistries other than lead acid or Ni-cad, but the fire codes and the ESS installation standard do not exclude UPS applications from ESS criteria including compliance to this Standard for these other chemistries.

1.6 The maximum energy capacity of individual electrochemical ESS shall be determined by the following in (a) – (d). Where the results of testing are used, the results shall be determined in accordance with the Standard for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems, UL 9540A:

a) The maximum energy capacity of residential use electrochemical ESS shall not exceed 20 kWh (72 MJ). This value shall be permitted to be increased to the value of the unit which meets the performance criteria of the UL 9540A Unit Level test;

b) The maximum energy capacity of non-residential use electrochemical ESS shall not exceed 50 kWh (180 MJ). This value shall be permitted to be increased to the value of the unit which meets

the performance criteria of the UL 9540A Installation Level test, provided the ESS is marked in accordance with 45.20;

c) There is no maximum energy capacity limit for non-residential use electrochemical ESS that are tested in accordance with UL 9540A in which the performance level criteria of the cell level test have been met; and

d) There is no maximum energy capacity limit for non-residential use electrochemical ESS intended for use in remote outdoor locations as defined in the applicable installation code, provided they are marked in accordance with 45.21.

NOTE 1: The Standard for the Installation of Stationary Energy Storage Systems, NFPA 855 defines outdoor remote locations as being located more than 30.5 m (100 ft) from exposures.

NOTE 2: Lead acid, Ni-Cad, Ni-MH, and Ni-Zn ESS have exceptions to the capacity energy limits including, in some cases, no limits based upon specific telecom and utility installations as outlined in NFPA 855.

2 Components

2.1 A component or equipment of an energy storage system covered by this Standard shall comply with the safety requirements for that component or equipment. See Annex A for a list of standards covering components generally used in the energy storage systems covered by this Standard. Components and equipment shall comply with the CSA and/or UL standards as appropriate for the country or countries where the energy storage system is to be installed.

3 Units of Measurement

3.1 Values and their respective units of measurement that are stated without parentheses constitute the requirement of the standard and those in parentheses constitute explanatory or approximate information.

4 Undated References

4.1 Any undated reference appearing in the requirements of this Standard shall be interpreted as referring to the latest edition of the reference, including all revisions and amendments.

5 Normative References

5.1 The following standards are referenced in this Standard, and portions of these referenced standards may be essential for compliance. Energy storage systems covered by this Standard shall comply with the referenced installation codes and standards as appropriate for the country where the energy storage system is to be installed. When the energy storage system is intended for use in more than one country, the energy storage system shall comply with the installation codes and standards for all countries where it is intended to be used.

ASME B31 (all applicable parts), *Power Piping*

ASME BPVC, *Boiler and Pressure Vessel Code*

ASTM D412, *Standard Test Method for Vulcanized Rubber and Thermoplastic Elastomers – Tension*

ASTM D4169, *Standard Practice for Performance Testing of Shipping Containers and Systems*

ASTM E136, *Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C*

29 CFR 1910.95, *Occupational Noise Exposure*

29 CFR 1910.1200, *Toxic and Hazardous Substances*

CSA C22.1, *Canadian Electrical Code, Part I Safety Standard for Electrical Installations*

CSA C22.2 No. 0, *General Requirements – Canadian Electrical Code, Part II*

CSA C22.2 No. 0.15, *Adhesive Labels*

CSA C22.2 No. 0.17, *Evaluation of Properties of Polymeric Materials*

CSA C22.2 No. 0.2, *Insulation Coordination*

CSA C22.2 No. 0.8, *Safety Functions Incorporating Electronic Technology*

CSA C22.2 No. 41, *Grounding and Bonding Equipment*

CSA C22.2 No. 94.2, *Enclosures for Electrical Equipment, Environmental Considerations*

CSA C22.2 No. 100, *Motors and Generators*

CSA C22.2 No. 107.1, *Power Conversion Equipment*

CSA C22.2 No. 107.3, *Uninterruptible Power Systems*

CSA C22.2 No. 139, *Electrically Operated Valves*

CSA C22.2 No. 286, *Industrial Control Panels and Assemblies*

CSA C22.2 No. 301, *Industrial Electrical Machinery*

CSA C22.2 No. 60079-2, *Explosive Atmospheres – Part 2: Equipment Protection By Pressurized Enclosure "p"*

CSA C22.2 No. 60529, *Degrees of Protection Provided By Enclosures (IP Code)*

CSA C22.2 No. 61800-5-1, *Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal, and Energy*

CSA C22.2 No. 62109-1, *Safety of Power Converters for Use in Photovoltaic Power Systems – Part 1: General Requirements*

CSA C22.2 No. 62368-1, *Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements*

CSA B51, *Boiler, Pressure Vessel, and Pressure Piping Code*

CSA B52, *Mechanical Refrigeration Code*

CSA B149.1, *Natural Gas and Propane Installation Code*

CSA FC 1, *Fuel Cell Technologies – Part 3-100: Stationary Fuel Cell Power Systems – Safety*

CSA Z462, *Workplace Electrical Safety*

CSA Z662, *Oil and Gas Pipeline Systems*

CSA E60730-1, *Automatic Electrical Controls for Household and Similar Use – Part 1: General Requirements*

ICC IBC, *International Building Code*

ICC IFC, *International Fire Code*

ICC IRC, *International Residential Code*

IEC 60068-2-52, *Environmental Testing Part 2: Tests – Tests Kb, Salt Mist, Cyclic (Sodium Chloride Solution)*

IEC 60364-4-41, *Low-Voltage Electrical Installations – Part 4-41: Protection for Safety – Protection Against Electric Shock*

IEC 60364-6, *Low-Voltage Electrical Installations – Part 6: Verification*

IEC 60417 Database, *Graphical Symbols for Use on Equipment*

IEC 60529, *Degrees of Protection Provided by Enclosures (IP Code)*

IEC 60664-1, *Insulation Coordination for Equipment Within Low-Voltage Systems – Part 1: Principles, Requirements and Tests*

IEC 60812, *Failure modes and effects analysis (FMEA and FMECA)*

IEC 60980, *Recommended Practices for Seismic Qualification of Electrical Equipment of the Safety System for Nuclear Generating Stations*

IEC 61000-4-2, *Electromagnetic Compatibility (EMC) – Part 4-2: Testing and Measurement Techniques – Electrostatic Discharge Immunity Test*

IEC 61000-4-3, *Electromagnetic Compatibility (EMC) – Part 4-3: Testing and Measurement Techniques – Radiated, Radio-Frequency, Electromagnetic Field Immunity Test*

IEC 61000-4-4, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and Measurement Techniques – Electrical Fast Transient/Burst Immunity Test*

IEC 61000-4-5, *Electromagnetic Compatibility (EMC) – Part 4-5: Testing and Measurement Techniques – Surge Immunity Test*

IEC 61000-4-6, *Electromagnetic Compatibility (EMC) – Part 4-6: Testing and Measurement Techniques – Immunity to Conducted Disturbances, Induced by Radio-Frequency Fields*

IEC 61000-4-8, *Electromagnetic Compatibility (EMC) – Part 4-8: Testing and Measurement Techniques – Power Frequency Magnetic Field Immunity Test*